Research and implement of CATIA parametric modelling-based cutter information integration in VERICUT

Xianguang Kong*, Yihui Li, Lei Yin, Xiaowen Wang

School of Electromechanical Engineering Xidian University, Xian, Shaanxi, 710071, China

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Abstract

In order to achieve the integration of the VERICUT tool library and tool management software, this paper studies the VERICUT tool integration technology based on CATIA parametric modelling. As the tool modelling ability is limited, VERICUT can neither achieve complex tool modelling nor generate the tool model by parameterization. Therefore, the secondary development based on VERICUT is unable to meet the integration requirements of tool information. This paper proposes a new integration approach, which transforms the integration of VERICUT and tool management software into VERICUT and CATIA tool information. Meanwhile, a feasible integrated development process is put forward. First, the tool model is parametrically driven by CATIA. Then, the integration of the CATIA tool library and tool management software is realized based on CAA. Finally, the transformation of CATIA and VERICUT tool model is accomplished, which indirectly realizes the integration of the VERICUT tool library and tool management software. During the NC machining simulation, VERICUT inherits the tool information and model generated by CATIA NC programming, which can ensure consistency with the tool information in tool management software. This paper solves the problem of integration of tool management software and VERICUT in the context of a digital manufacturing project; successful application of the proposed approach has greatly improved the efficiency of NC programming.

Keywords: VERICUT, CATIA, tool management software, parametric modelling, TLS, CAA

1 Introduction

VERICUT, an NC machining simulation software pushed out by CGTECH, can simultaneously simulate the tool path and the machine tool, to detect potential problems in machine processing. In order to realize the simulation of NC machining processes, VERICUT first establishes the geometric and kinematic model of the machine tool, then builds other manufacturing resources, such as the geometric model of cutters, workpieces and fixtures, and specifies the tool path or the NC program and sets appropriate parameters. This is followed by the simulation and optimization of the machine process. Meanwhile, widely applied in enterprises, tool management software can effectively manage information about tool components, tool diagrams and tool suppliers. However, each of the two kinds of software has its own tool library. They manage and use the tool information independently, therefore resulting in the problem of "Information Island", which prevents workers from dynamically calling the tool information from the software. Workers have to adjust and maintain tool information, which leads to a big workload and is error prone [1].

In order to allow VERICUT to dynamically call the tool information from tool management software in the NC machining verification, there is a need for a secondary development based on VERICUT. However, VERICUT only provides a standard method to shape models because of limitations of its tool modelling function. That is, it designs tool profiles with a symmetrical rotary centre and composed of lines and arcs by profile definition, and cannot build complicated tool models. The most important issue is the fact it does not have the function of parameterized modelling. The above problems result in a VERICUT tool model that cannot vary with the tool attribute value. Therefore, integration of tool information cannot be achieved by a secondary development based on VERICUT.

To this end, this paper proposes a new integrated approach. When using VERICUT for NC machining simulation, we take advantage of the 3D parametric modelling function of CATIA to establish the tool models in NC processing, and generate VERICUT tool models with CATIA as the parametric design platform. Thus the consistency of tool information in the VERICUT NC machining verification process and tool management software is achieved. This paper presents a case study based on a digital manufacturing project, and solves the problem of integration of tool management software and VERICUT. Through the integration of the VERICUT tool library, NC workers can directly inherit tools from the CATIA tool library, and are able to master the conditions of existing tools, thereby improving the efficiency of NC programming.

* ***Corresponding author*** e-mail: kongxg@vip.sina.com

2 VERICUT tool integration approach based on CATIA parametric modelling

CATIA NC programming and VERICUT NC machining verification are two closely linked aspects. VERICUT uses the NC code generated by CATIA for NC machining verification. Therefore, the problem of tool information consistency in VERICUT and tool management software is solved when the following is ensured; the tools selected in CATIA NC programming are in the tool management software, and VERICUT NC machining verification only needs to inherit the tool information and models in CATIA NC programming [2].

The VERICUT tool library contains information of the cutting part, cutter bar and clamping part, which is stored in the tool library files in TLS format, and is used after calling the tool library, which is already set to edit. When using VERICUT to do NC machining simulation, the first step is calling the NC program in the VERICUT circumstance, and then defining the tool list to build the mapping relationship of the tool number assigned in G-code and the main tool library file [3]. The NC code is generated by CATIA and the tool's ID number in the NC code is what is recorded in the tool library. We need to extract the tool's ID number and assign the tool's attribute value to the VERICUT tool library. This can indirectly realize the integration of information from the tool management software and VERICUT.

Different tools with different machining processes in NC machining result in different specifications of tool models, with different tool selections, generated by VERICUT tool TLS files. As the tools only have attribute value in tool management software, and VERICUT tool model information is stored in the tool library files in TLS format, we can build a tool model in CATIA and then generate the TLS files [4]. The integration scheme of tool management software and VERICUT is shown in Figure 1. The integration is of of CATIA and VERICUT, which realizes the integration of tool management software and VERICUT.

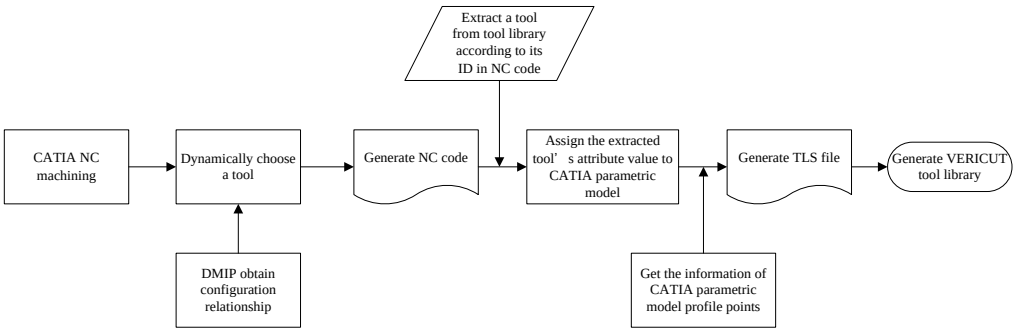


FIGURE 1 The integration scheme of tool management software and VERICUT

3 Tool integration development process

3.1 BUILDING THE PARAMETRIC TOOL MODEL BASED ON CATIA

There are two methods for parametric modelling in CATIA. One is the program driving method, which uses advanced object-oriented language such as VB, VC, C++, etc. to drive CATIA by editing command to draw the parametric model; the other is the dimension driving method. The former can directly call the API object to draw graphics. As the graphics are completely generated by the program, there is a large amount of code, and programming is difficult [6]. The program has to be run every time a part is generated, resulting in a low running speed. However, the latter can modify the parameters to change the model. The code of this program is simple and has a high running speed. Considering the running speed and the low difficulty of tool modelling, this paper uses the dimension driving method to build the tool model [7, 8].

The parametric design method can generally be divided into the following four steps:

1. Extract geometric feature parameters and do customized naming;

2. Establish the corresponding mechanism of geometrical quantity numerical information and parameters, as well as the corresponding relations among the parameters;

3. Edit parameters to modify geometric entities indirectly;

4. Introduce the parameter verification, supervise the design process and test whether the design meets the requirements.

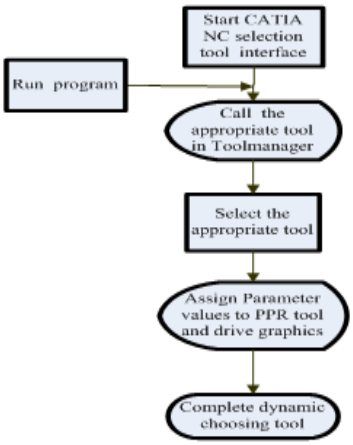
The operating process is as follows; Open CATIA, and enter the Part Design module. Click *f*(*x*) and establish the tool parameters, number the tool contour points, revolve the tool contour line and generate the model. Click *f*(*x*) and choose the parameter of the Part Number, click "add formula", choose "Part Number" in the parameters on the feature tree, then click OK. The establishment of the tool parametric model is then completed [8].

3.2 PARAMETRICALLY DRIVE AND GENERATE CATIA TOOL MODEL

As the powerful engineering software, CATIA has high flexibility. Users can conduct various developments with different methods according to their needs. Specifically,

there are two ways of secondary development of CATIA: Using micro and Component Application Architecture (CAA). As a platform for Dassault Systemes products extension and customers customizing and developing, CAA uses object-oriented programming (OOP) language, which has become the mainstream of software development and design. Using COM technology and OLE technology, the development of CAA can be regarded as a combination and expansion of its component objects. As a type of software architecture, COM has better module independence and scalability, which makes the programming of CAA much easier and more standardized, with more concise code [9].

In view of this function, there is a need to call the tools in the tool library of the tool management software, and dynamically assign the tool's attribute value to the tool model in the CATIA NC machining module. Therefore, we adopt the CATIA tool integration method based on CAA to achieve the generation of the CATIA tool model through dynamic data calls and parametric drive. The integration scheme is shown in Figure 2.



FIGIURE 2 Tool library integrated solution

3.3 REALIZING THE TRANSFORMATION BETWEEN CATIA AND VERICUT TOOL MODELS

The integration problem of CATIA and VERICUT to be solved is how the contour point coordinates of the tool model in CATIA can be transformed into that in VERICUT, that is, how to generate the *.TLS file[10]. As part of the VERICUT tool library file, the TLS file contains cutter and toolhoder description data used for cutting simulation. The TLS file can be expressed by the following example:

CGTECH Tool Library File
Version-5.4
TOOLID "1" {
UNITS MILLIMETER
TOOLTYPE MILLING
STACK YES
CUTTER {ASSEMBLY {SOR { PTS { (0,0) (0.75,0) }
ARC (0.75,0.25,0.25) CCW
PTS {(1,0.25) (1,0.625) (0.5,0.625) (0.5,1.125) (0,1.125) }
COLOR 6 }}}}

This indicates that a tool, with its ID as 1, has a profile consisting of straight lines and arcs. The endpoints of the straight lines are (0, 0), (0.75, 0), (1, 0.25), (1, 0.625), (0.5,0.625), (0.5, 1.125), (0, 1.125), the centre of the arc is (0.75, 0.25), the start point is (0.75, 0), end point is (1, 0.25), the radius is 0.25, and the direction is counter-clockwise. The unit is mm [12].

This shows that the TLS file generates the tool model using information about tool contour points. Therefore, reading the coordinates of the points is an important step.

The development process is shown in Figure 3:

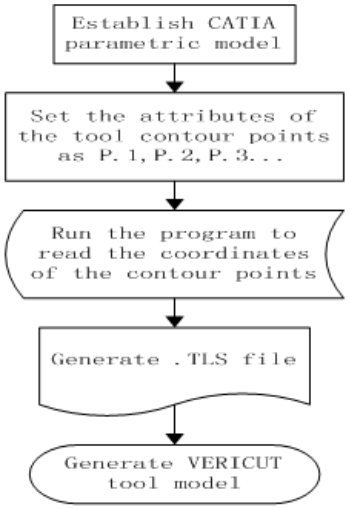


FIGURE 3 The integration process of VERICUT and CATIA

4 Development and validation of tool integration module

Using Windows Server 2000, Windows 2000 Professional/XP/NT operating system, SQL Server 2000 database management system and Delphi 7, this paper achieves the development of a tool information integration module based on VERICUT. The realization process is shown in Figure 4. After debugging and verification, the platform is officially used in enterprises, and solves the problem of "Tool Information Island" between CATIA, tool management software and VERICUT [11].

The module based on VERICUT has two major functions:

1. Transformation of the tool in NC files into a CATIA physical model: assignment of the attribute value of the tool in the tool management software to the CATIA parametric model;

2. Direct generation of the TLS file tool shape in VERICUT: transformation of the contour points coordinates of the CATIA physical model into a .tls file; finding it in the tool management in VERICUT, and

opening it to generate the tool shape after saving the TLS file in the designated location.

Based on the above two types of integration, this paper achieves the integration of tool management software and VERICUT, which enables the transformation of NC code to TLS file, so that tool information generated by VERICUT is consistent with that used in the previous step. The generating speed of the VERICUT tool is also increased, and the consistency of the tool information is ensured.

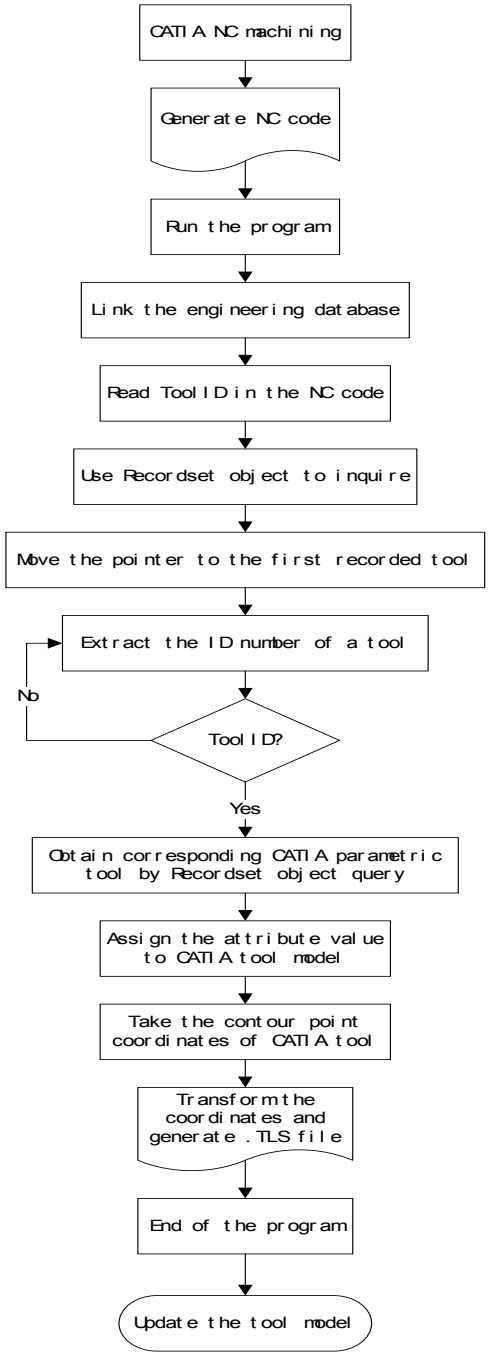


FIGURE 4 The development process of tool integration model based on VERICUT

5 Conclusions

Based on a digital manufacturing project, this paper studies the VERICUT tool library integration technology, analyses the structure and establishment theory of the VERICUT tool library and the tool integration method of VERICUT. The usage of parametric modelling, based on CATIA is proposed to realize VERICUT tool information integration. Through the tool information integration of CATIA and tool management software, as well as CATIA and VERICUT, the integration of VERICUT and tool management software is achieved. In addition, combined with the practical situation, we developed a software

module that realizes the integration of the VERICUT tool library. The successful integration of the VERICUT tool library and tool management software plays the following role:

1) Greatly reduced the quantity of work associated with setting the tool parameters, and improved the efficiency of NC programming by directly inheriting the tool information from the NC code generated by CATIA during the NC programming.

2) Through the integration of the VERICUT tool library, the selected tool in the NC verification is related to the production field tool, which ensures the suitability of the NC program.

3) Improved the degree of automation and integration of the digital manufacturing system.

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Authors

Xianguang Kong

Current position, grades: Associate professor at Xidian University, College of Mechanical & Electrical Engineering.
University studies: Ph.D in Mechanical Manufacturing and Automation (2005, Northwestern Polytechnical University).
Scientific interest: advanced hybrid manufacturing technology, CAD/CAPP/CAM/CIMS.

Yihui Li

Current position, grades: Doctor of Engineering, Director of Application of information technology Research Office, Xi'an High Voltage Apparatus Research Institute Co., Ltd., Xi Dian Group, China.
University studies: Ph.D on Mechanical Manufacturing and Automation (2009, Northwestern Polytechnical University).
Scientific interest: enterprise informationization strategy, enterprise resource planning, it planning, digitized manufacturing technology.
Publications: 3 patents, 10 publications.

Lei Yin

Current position, grades: Associate Professor at Xidian University.
University studies: Ph.D. in Northwestern Polytechnical University (2000–2005); Postdoctoral in Xidian University(2007-2010).
Scientific interest: system modeling and simulation.
Publications: 4 patents, 16 publications.

Xiaowen Wang

Current position, grades: Postgraduate at Xidian University, College of Mechanical & Electrical Engineering.